Preliminary Observations on New Images of the Elysium Frozen Sea Deposits from HRSC Mars Express

Conference or Workshop Item

PRELIMINARY OBSERVATIONS ON NEW IMAGES OF THE ELYSIUM FROZEN SEA DEPOSITS FROM HRSC MARS EXPRESS. John B. Murray[1], Matthew R.Balme[1], Jan-Peter Muller[2], Jung-Rack Kim[2], Jeremy Morley[2], Gerhard Neukum[3] & the HRSC Co-Investigator Team. [1]Dept. of Earth Sciences, The Open University, Milton Keynes MK7 6AA, U.K. j.b.murray@open.ac.uk [2] Dept. of Geomatic Engineering, University College London, Gower St., London WC1E 6BT, U.K. [3] Geosciences Institute, Freie Universität Berlin, Malteserstr. 74-100, Building D, 12249 Berlin, Germany.

Introduction: A series of recent image strips across Cerberus Fossae and Elysium Planum taken by the High Resolution Stereo Camera aboard the Mars Express spacecraft have extended our knowledge of the frozen sea deposits [1,2,3,4] in Elysium. We now have complete coverage of an area about 200 x 600 km at resolutions down to 12 metres, as well as hundreds of MOC NA images at resolutions down to ~1 metre. This area has alternatively been interpreted as a very high volume flood basalt lava [5], but the new images show features characteristic of sea ice in the Arctic and Antarctic oceans, particularly pressure ridges, finger rafting and open water lanes, throughout the entire area covered. The water originates from the Cerberus Fossae, a series of young fissures to the northwest (fig. 1), from where it flowed down the Athabasca Valles and associated channels.

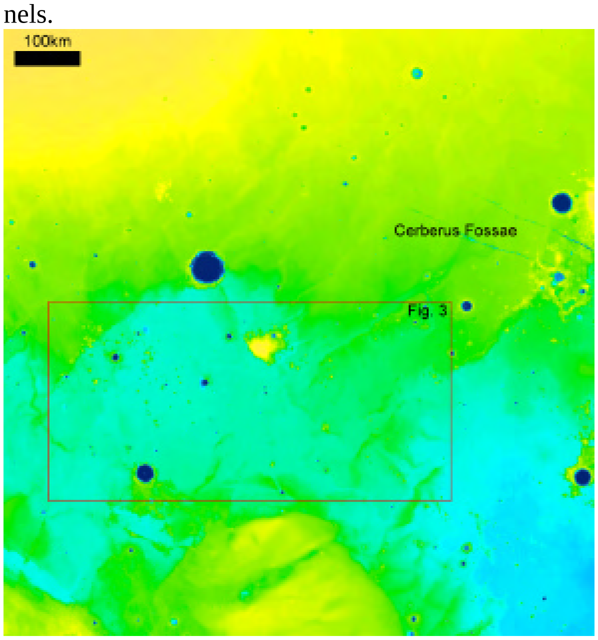

Fig. 1. MOLA topography showing the area mapped in fig. 3. The centre is approx 152.5E, 8N.

Extent of the frozen sea: This has been mapped using the presence of ice-floe outlines. MOLA topographical data show that most of the surface slopes are considerably less than 0°.1. It is clear that the frozen sea extends beyond the HRSC imaging strips, and THEMIS and MOC NA images suggest that it may be as large as 800 x 2500 km. With a water depth of 50 metres [4], the total volume of water would have been between 5000 and 75,000 km^3. However, there are several places where ponding and subsequent overflow has occurred, eroding downstream drainage channels to lower levels where the water has again ponded. The whole complex comprises a series of lakes and connecting drainage channels of comparable dimensions to the Great Lakes in North America. In other places, relatively small overflows have occurred, cutting channels that end in deposited sediments around 5 km across with distinct fronts characteristics of mudflows. In the east there is a much larger overflow, possibly the result of more than one major water eruption, that also has successive drainage channels with sand bars and eyots that lead into flatter areas where deposition and apparent mudflows have formed on a much larger scale, the whole complex stretching for more than 100 km.

Ice movement: Flow channels are visible within the main ponded areas, sometimes near the centre, as sinuous floe-free lanes with aligned floes either side of the channel. There are also several places where drift of the ice has taken place after initial formation, leaving characteristic pressure ridges upstream of obstacles, and downstream lanes that indicate direction of drift (fig. 2). A map of ice drift directions derived from such lanes is shown in fig. 3. The drift is more or less consistent with flow direction expected from visible channels both between and within the lakes. In several places, large cracks have formed parallel to the shoreline, the direction of ice drift being detectable by matching the two sides of the crack. In these cases, the drift of ice has been away from the shore. Taken together, the above drift directions suggest that this lowering of the water level was due to downstream drainage rather than evaporation or seepage into the sea floor.

Shoreline: In many places, ice ridging can be seen along the shoreline. In other places where ice has drifted away from the shore, small scale striations normal to the shoreline suggest a beach-like area with downslope channeling. In other areas, particularly along the northern edge, features become ill-defined and discontinuous, suggesting that extensive sublimation, or eolian or other erosion has taken place. Along much of the southern border however, it is clear that more recent aeolian deposits overlie the frozen sea. The pack-ice surface is occasionally exposed as an inlier within these deposits, and if these were more extensive in the past, it may be that they have protected the ice from sublimation. If they were of sufficient thickness, they may also have protected it from impact cratering, so the true age of the frozen sea may be older than the 5 my indicated from crater counting [4].

References: [1] Brakenridge G. R. (1993) *LPS XXIV*, 175. [2] Scott D.H. & Chapman, M.G. (1995). Geologic and topographic maps of the Elysium paleolake basin, Mars. USGS MAP I-2397. [3] Rice, J. W., Parker, T. J., Russel, A. J. & Knudsen, O. (2002) *LPS XXXIII*, Abstract #2026. [4] Murray J.B. et al. (2005) *Nature, 434,* 1151–1154. [5] Keszthelyi, L., McEwen, A.S. & Thordarson, T. (2000) *J. Geophys. Res. 105,* E6, 15,027-15,049

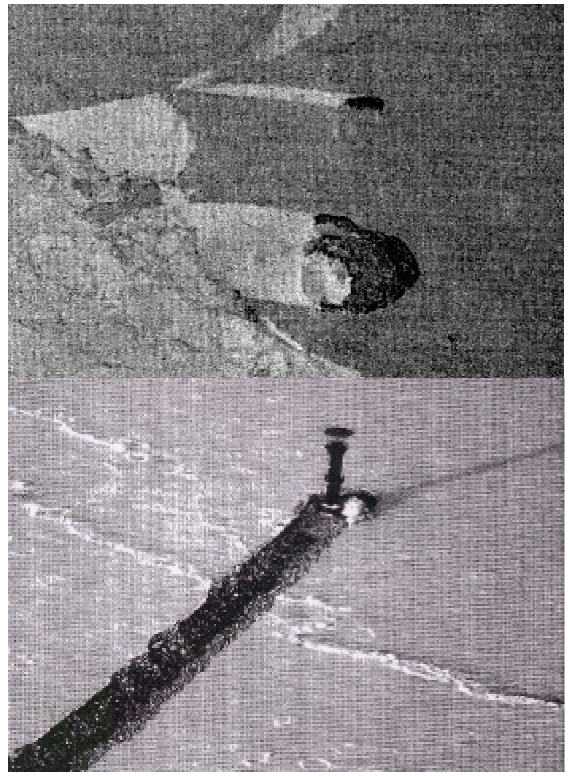

Fig 2 *Top:* Lanes downstream of obstacles in the Elysium frozen sea. *Bottom:* Similar lane downstream of a lighthouse, Baltic Sea, with ice pressure ridges.

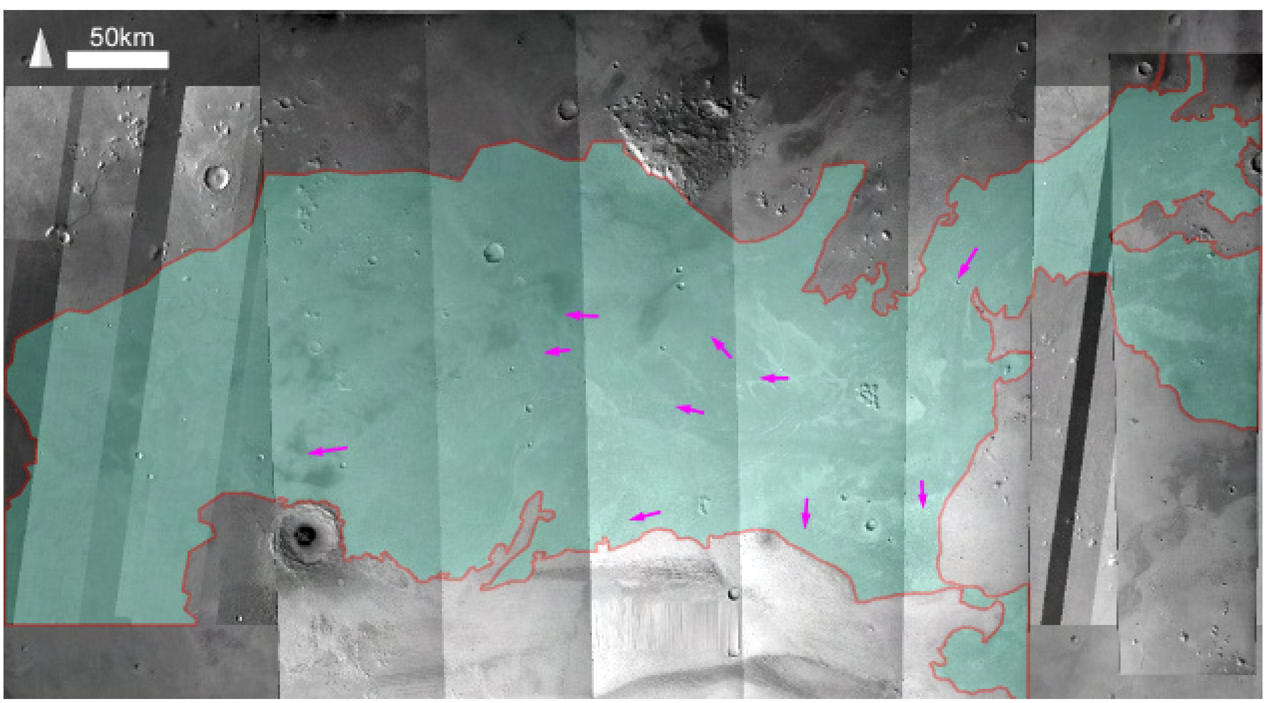

Fig 3: Mosaic of HRSC and THEMIS daytime IR images, with preliminary map of the frozen sea superimposed. Arrows show direction of movement of ice derived from downstream lanes as in fig.2.